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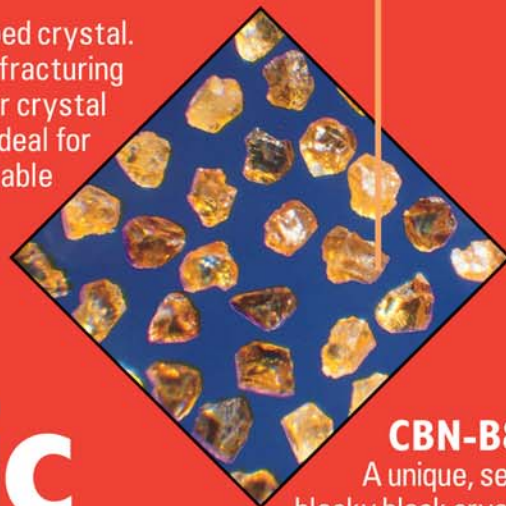
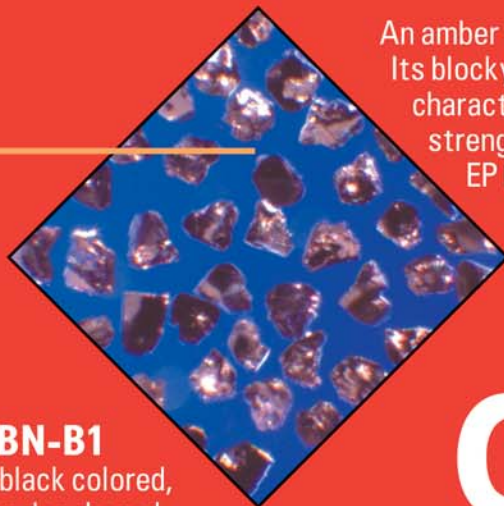
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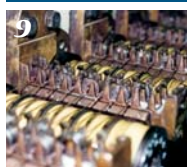
COVER PHOTO

Photo of polycrystalline wire dies and wire applications, courtesy of AGI Photographic Imaging, Inc. and Diamond Innovations

FINER POINTS is the only publication devoted exclusively to the understanding, selection and application of diamond, cubic boron nitride and related materials. It is edited for recipients who are involved in some way with these "superabrasives", either as providers of the materials, producers of products containing the materials or users of these products (e.g., grinding wheels, dressing tools, drill bits, saw blades, sawing wires, cutting tools, polishing compounds, CVD film products, etc.).

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A Finer Point of View...

Five Essential Traits Of Effective Leaders

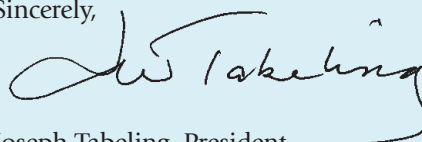
It's college commencement time and I'm proud to say that one of our children has reached this milestone in his life. We were often reminded that this was the class of 9-11. Just after leaving the security of their homes and families, the world shook and at a most vulnerable time, they were tested. Linda vividly remembers the anxiety in our son's voice during the first phone contact that fateful day. So it was fitting that Rudy Giuliani presented the Commencement Address to this class. The former mayor is a public personality who earns respect, even though we may not agree with all of his views. His response to the attack on the World Trade Center remains a classic display of leadership in the face of chaos. Since leaving office, he's been speaking and writing on the subject of leadership and he took the opportunity before these "future leaders" to point out five essential traits of effective leaders. The first trait is an unshakable, always visible, belief in a core value. Rudy reminded us of our country's strength and resolve in the face of similar attacks and his faith that we would overcome this one too. Next is an optimistic attitude. There are always people who'll pay attention to the naysayers and doomsday prophets. More people will follow those who identify the positive aspects of people and situations and offer a more hopeful picture of the future. Courage is the third attribute. Rudy spoke of controlling your fear, not what we'd normally consider bravery. Firefighters and police officers that became heroes were terrified to appear at press conferences. Clearly the self-control needed to be composed in a variety of stressful situations comes first from self-knowledge. Effective leaders practice constant preparation. There is no way that New York planned for a terrorist airliner attack on the World Trade Center but they planned for high rise fires, a building collapse, airplane crashes, underground fires, etc. Rudy discovered that by preparing thoroughly he could be confident that what he hadn't prepared for could be handled with slight modifications to existing plans. Lastly is love. Attend more funerals than weddings because that's where people need your support. President Bush rushed to the World Trade Center site despite the fears of a follow-up attack and visited one-on-one with everyone from government executives to construction



PRESIDENT
Joseph Tabeling

workers listening, affirming and supporting the front line. There are lessons here for us when leading our families, our companies and other groups we've joined. More interesting are the areas where a leadership vacuum exists. What responses have we seen to the threat of rapidly growing Eastern industries? Entrenched interests force a continuation of the failing status-quo, we're instructed in how a floating Yuan will result in decades-long US recession, and little cooperation exists among companies in re-inventing their industry's role in satisfying customer needs. The industrial diamond industry with dramatic new manufacturing technology, significant funding of research on a national level, and new applications across all industries is positioned to adapt to the new business reality. We need a firm belief in our strengths as they apply to our future role. Recognize what's going well right now and commit to make it do even better. Evaluate what could go wrong and prepare for it so you're in control when it happens. Teach others what's worked for you and coach them as they go through the process. Graduation is called a "Commencement" because of the new lives begun by the participants. Let's look at the opportunity that the changing world economy presents, apply our considerable leadership experience, and start the process of reinvention needed to continue growing.

Sincerely,



Joseph Tabeling, President
Industrial Diamond Association of America



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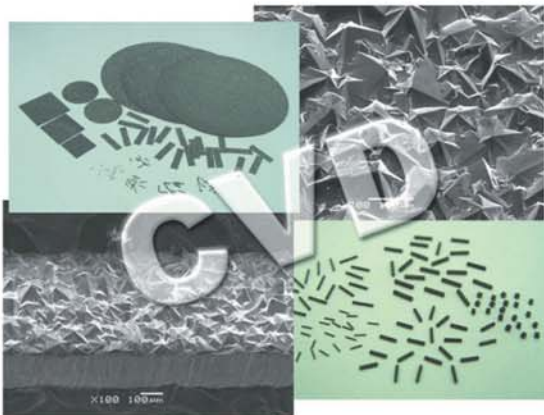
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The Wire Drawing Story

By BRAD SCHERER, Fort Wayne Wire Die, Inc.

What do an incandescent light bulb, steel belted radial tire, personal computer, telephone, electric motor and piano all have in common? None of these products could function without wire. I won't go so far as to say the world revolves around wire, but it is amazing how dependent we are and how much we take for granted a simple material like wire.



Photo 1

Wire dies using natural and single crystal synthetic diamond



Photo 2 – Wire sets in drawing operation to reduce wire diameter

A wire drawing process using a wire drawing die produces nearly all types of wire regardless of the material (**photo 2**). A wire die is a wear-resistant tool used in a wire-drawing machine to sequentially reduce

the diameter of wire to a desired size. It consists of a wear-resistant material such as diamond or tungsten carbide that has been drilled with a conical hole, profiled and polished to exacting tolerances and housed in a stainless steel casing (**graphic 1**). The type of wear-resistant



Graphic 1

material used in a wire die is determined by: the wire material drawn, die life expectancy, finished product requirements and budgetary constraints. Generally, tungsten carbide dies are still used to produce high and low carbon steel wire, while most of the non-ferrous and fine wire industries have converted to single crystal diamond or polycrystalline diamond wire dies (**Photo 3**).

According to archaeologists the principle of drawing wire through a die dates all the way back to 3000 B.C. It is presumed that braided gold wire and gold fabric were produced using a die to draw them. Those early dies consisted of iron or fire-hardened wood and were used until about 1500 A.D. when the French devised the use of rubies as a die material after the Swiss successfully engineered rubies as bearing material in watches. As the Industrial Revolution progressed into the 19th century the need for a harder, more durable die material evolved. The result: nature's hardest material single crystal natural diamond. However, it was not until 1860 that the first bore was drilled through a diamond.

The early methods for drilling a hole in diamond consisted of using a shaped, sharpened needle to a microscopically fine point. The needle drilled away at the

revolving diamond while the operator added diamond powder and continuously sharpened the needle. Using this process it would take 3-4 days before a hole would finally be pierced through the diamond. After the hole had been successfully drilled it was polished with wire slightly smaller than the hole and fine diamond powder. Although the making of a diamond die appeared to be simple and only required patience, the art of die making was not easily learned. In fact, the United States did not have its own diamond die industry until the mid 1920s and even then the diameter sizes were limited from the largest of .114" (2.9mm) to the smallest of .01011 (0.25mm). Nearly all dies smaller than .010 inches were imported from Europe until the late 1930s when one die manufacturer began producing dies as small as .002" (0.05mm). As automobiles and radios became available to the average American the demand for fine dies grew with the need for the fine wire used in those products. The demand

for fine wire soon increased dramatically due to World War II and the production of machines of war. With advances in electronics and electrical products the drawing of enormous amounts of fine wire became of absolute importance to the war effort.

The United States government quickly realized the dependency of American wire drawers on dies imported from Europe and that production of diamond dies smaller than .002 inches was almost nonexistent in the United States. Steps were taken to overcome this shortage. The United States government, in the form of the War Production Board, initiated a program to teach the art of diamond die making and to research a method for the manufacture of very fine dies. The Board's efforts were rewarded in less than two years when the United States' production of fine diamond dies matched or exceeded demand. The success was based upon the acquisition of overseas patents on the process of piercing diamond with a sparking electric needle. A variation on this same, patented idea was used and the electrolytic method became the standard method for piercing diamonds for the manufacturing of fine diamond dies.

In the 1960s it became feasible to use lasers in the piercing of diamonds (**Photo 4**). But the advent of laser technology was not the answer to all the problems in the fabrication of a wire-drawing die. The problems die makers faced in introducing laser drilling to their manufacturing process included diamonds shattered by the laser beam and the proper shaping of the crude hole original lasers drilled. The hole sizes manufacturers could successfully drill with a laser were severely limited in the early days. As technology has



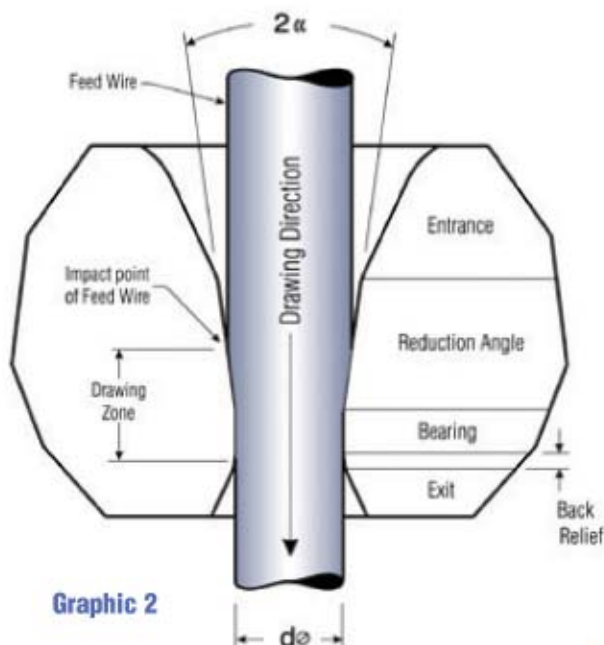
Photo 3 – Polycrystalline wire dies

Photo 4 – Laser drilling of diamond wire die



advanced, the die manufacturers have learned to make dies in finer and finer sizes using the laser.

Another new technology to advance the manufacture of diamond dies is the application of ultra-sonic equipment. The extremely high frequency vibration of a needle combined with diamond powder is used to remove diamond and form the final shape of the die. Ultrasonic equipment used in conjunction with a laser has greatly reduced the time it takes to manufacture a diamond die while increasing the precision required. The precision required to make a diamond die is matched only by the ability to choose the proper die material. Since wire is cross-sectionally reduced by being drawn at high speed through the funnel shaped interior of the die, it is necessary for the center of the



Graphic 2

die material to be well polished and free of flaws (**Graphic 2**). Selection of the most appropriate diamond die material depends on many factors, including the type of wire material being drawn, speed of the machine, type of lubrication being used, finished product requirements and budget constraints.

Single crystal natural diamond is in many ways the ultimate wire drawing die material (**Photo 5**). Because of its very high hardness it has the greatest resistance to abrasive wear of any die material. It can be polished to a shine that matches any diamond gem surface. This unique property is especially important to fine wire drawers (below .010 inches) from the standpoint of minimizing friction (and the resulting wire breaks) as well as the positive effect on the wire surface. When the wire surface finish is an important requirement, single crystal diamond dies are usually the product of choice, especially in the final few dies of the die sequence. Another important characteristic of single crystal diamond is its high thermal conductivity. As you can imagine there is a tremendous amount of heat generated in the high-speed wire drawing process. Because diamond has 6-10 times better thermal conductivity than tungsten carbide it is better



Photo 5 – Natural Diamond wire die

suited for conducting heat away from the drawing zone, thus lengthening die life. The primary limitation of natural diamond in wire drawing dies is high cost resulting from the limited supply or availability of large size, high quality diamonds. Single crystal diamond, although extremely hard, does not possess very high strength. It is relatively brittle and susceptible to breakage when encountering a shock in its cleavage plane. Single crystal diamond is a unique material in that its hardness and wear resistance is directional depending on the plane of its orientation. If improperly oriented a diamond will wear in a non-uniform manner and can create badly out-of-round wire over time. Today, single crystal natural diamond wire dies are being used in sizes as small as .0003" (7.6 micron) about 1/10 the diameter of a human hair, for precise applications such as the gold bonding wire as leads in an integrated circuit. The maximum hole sizes where single crystal natural diamond is used as a wire die today are somewhat limited above .040" (1.02mm), and severely restricted above .100" (2.54mm) due to the economic and functional limitations mentioned above. Since the introduction of polycrystalline diamond in 1974, polycrystalline diamond has made many in-roads in the wire industry (**photo 6**). Today, there are 2 major suppliers of polycrystalline diamond die blanks. Each offers a wide variety of die blank sizes and grain sizes to suit specific requirements. As the name implies, polycrystalline diamond is comprised of many small particles of diamond and metallic catalytic elements that have been compacted under intense heat and pressure into a synthesized die blank. The random orientation of these small diamond particles created a new die material that was more resistant to wear and fracture than even single crystal diamond. The ability of some manufacturers to produce polycrystalline die blanks as large as 40mm (1.57") diameter x 20mm (0.79") thick has opened new markets to die makers such as rod drawing, tube drawing and stranded wire compacting and bunching which were previously dominated by tungsten carbide. Originally, polycrystalline die blanks gave die fabricators a problem in achieving a polish acceptable to wire drawers. Polycrystalline blanks cannot achieve



Photo 6 – Polycrystalline diamond die blanks

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Photo 7 – Synthetic single crystal diamond die blanks

Copyrights and Copywrongs

Recent civil actions against people who have violated the copyrights of music and movies have rekindled a pet peeve I have always harbored against those who would steal another's work or creative efforts. The UK music industry recently claimed victory in its first battle with illegal file-sharers after 23 people paid \$87,900 to settle out of court. In other action, police in a dozen countries seized computers and made arrests in a raid of Internet pirates in the United States, Netherlands Australia, Israel, Germany, South Korea, Norway, France, Sweden, Denmark, Russia, Poland, Canada and Hungary. This raid disrupted sophisticated groups that were responsible for almost 95% of copyrighted material that was available illegally online. I hope this is just the beginning and the long arm of the law continues to punish violators on an international basis. Copyright laws are a form of protection provided to the authors of "original works of authorship," including literary, dramatic, musical, artistic, and certain other intellectual works. This protection is available to both published and unpublished works. In other words, if you draw it, write it, record it or take a photo of it, you own that work. Of course exceptions are provided if you are working for another company and have creative agreements with them... then it belongs to that company.

The Industrial Diamond industry has a long history and vast resources of "intellectual property" that need to be protected and we all must take the lead in protecting our valuable assets whether they are photos, articles, technical papers, research projects or other works. This issue is especially near and dear to my heart because of my unique position in representing so many companies. In my work I spend hours doing research and I periodically come across a photo or direct text that I recognize as originally published by the Association or one of our members. I take action to notify the companies involved in the hope of heading off further copyright infringement. Many times I have found that companies do not fully understand the laws and a simple request is all that is needed for them to cease and desist using the copyrighted material.

With the advent of the Internet and relative ease of researching, viewing and copying photos and text, "cut and paste" technology has become a growing problem. More companies or individuals feel it is OK to just take whatever they see and use it wherever they choose. This is not the case... it is illegal, not to mention there is a certain integrity problem with those who would steal another's work.

A few years ago a company applied for membership to the IDA and with their application they supplied a website to further review their products and capabilities. To my amazement their site had photos of products that were obviously pirated from member websites and even were using trade names of member companies as their own product names! I notified them of this problem and they were very sorry for their error... they thought these were generic industry classifications! I must admit they subsequently did change their product names and removed the photos.

The worst violators, across all industries, have come in the form of new pirates that operate under self-justified and misinterpreted labels they call freedom of expression, fair use, common property, or public domain. They use these terms as ways to usurp the rights afforded to those who create the original work. Copyright criminals and pirates aren't only stealing music and movies, they are infringing on the very building blocks of our industry. We all should actively pursue these pirates and support any regulatory legislation to stop the theft of intellectual property. Greater efforts must be implemented to safeguard the years of hard work and the valuable knowledge base that is the core of the Industrial Diamond industry.



TERRY KANE, Editor

All Diamond Tools Are The Same...



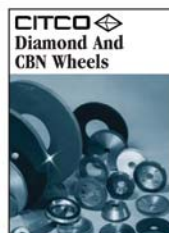
In Your Dreams.

Fact is that diamond and CBN grinding wheels, dressers, and cutting tools are as different as the companies that supply them. That's why you'll find the CITCO name on the wheels and tools that handle the critical jobs in automotive, aerospace, and general manufacturing. Hardened steel, ceramics, laminates, superalloys, composites, reinforced resins, abrasive materials, you name it and CITCO wheels and tools will tame it.

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the same degree of polish that is possible with single crystal diamond. This is why single crystal diamond is still preferred by wire drawers of fine sizes and plated wires. However, die fabricators have improved their polish methods to the point where most wire manufacturers find that the surface of wire drawn through polycrystalline diamond dies is quite acceptable in most applications. Thus, the market penetration of polycrystalline diamond into the non-ferrous wire industry is nearing completion.

Beginning in 1986, a third superabrasive die material made its appearance. Since then, single crystal synthetic diamond has gradually penetrated the markets then held by single crystal natural diamond dies (*photo 7*). The benefits and performance of single crystal synthetic diamond dies are very similar to single crystal natural diamond dies from an end-user standpoint. The benefits of single crystal synthetic diamond from a die maker's point of view are more obvious. Synthetic, single crystal diamonds are nearly flawless stones of predetermined sizes that eliminate the need for stone selection and sorting as required with natural diamond die stones. They are also pre-oriented and have flats already ground on each side of the stone; thus, eliminating a step which would be required with a natural diamond. In spite of these conveniences to the die maker, single crystal synthetic diamond has made only minor inroads in the market place thus far, primarily due to the high cost of synthetic die stones in the larger sizes. As the cost of natural diamond die stones continues to increase year by year, it is only a matter of time before the single crystal synthetic diamond will see significant market



Photo 8 – Spooled drawn wire

penetration as a suitable replacement to the single crystal natural diamond die.

Contrary to popular belief, fiber optics has not, nor is likely to ever, fully replace the need for metallic wire (*photo 8*). As we move through the information age, the need for wire will continue to expand. The rebuilding of infrastructure in the eastern economies, the expansion of communications and power systems in the Third World and the trends toward miniaturization, automated conveniences and the information super highway all spell a strong demand for wire and the diamond wire drawing die well into the 21st century. ■

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Prevention of Failure Modes in Polycrystalline Diamond Wire Dies

By DAVID BRIGGS, Product Manager
Wire Dies Diamond Innovations



THE WIRE DRAWING PROCESS

The process of wire drawing, like the name implies, consists of drawing a wire of a larger diameter through a die with smaller diameter thereby reducing the diameter through plastic deformation while the volume remains the same. To accomplish the desired wire diameter a wire is drawn through a series of incrementally reduced dies until the final wire size is achieved (*photo 1*). Not all metals or alloys possess the physical properties necessary to make useful wire. The metals must be ductile and strong in tension. These qualities determine how useful a wire will be in its final application. Every wire type requires specific processing techniques to achieve the desired quality and size. Wire can be made from copper, steel, platinum, gold, silver, aluminum and iron as well as from other alloyed metals. Special purpose wire is also made from tungsten for light filaments due to its high temperature properties (*photo 2*). Wire is made in large diameters and gauges for construction cables and heavy duty electrical use down to extremely fine wire for special purposes. Making wire is an ancient science which began with cutting metal in strips and hammering it into a round diameter. Still later, drawing was used to process fine gold threads for textiles. True wire drawing, as we know it, actually began in Europe during the sixteenth century. Wire dies were initially hard metals like iron or gemstones like rubies. Eventually carbide and natural diamond became more common. Since being introduced in 1974, polycrystalline diamond (PCD) dies have made tremendous advancements in productivity and quality in wire drawing applications.

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FABRICATION AND APPLICATION, OPPORTUNITIES FOR ERROR AND FAILURE

Wire die fabrication and applications are demanding processes with numerous steps involved. Die fabrication involves applying pressures and temperatures (photo 3) as well as drilling with lasers, diamond needles and wire through the PCD core. All of these can cause the die to wear and fail in a number of different ways. Each step subjects the diamond core to new opportunities for error and failure. In polycrystalline dies this wear or failure can be delayed and the die life extended by understanding how dies typically fail. The most frequently occurring defects in wire dies are: 1) Cracks or fractures, 2) Rough diamond bore 3) Pitting 4) Excessive wear rings and 5) Broken die blanks. The following analysis identifies the potential causes of die failure and is a valuable guide to preventing such issues from occurring.

1) Cracks or Fractures - The 4 Primary Types Seen in Wire Dies

The most frequently occurring defects in wire dies are cracks or fractures. Cracks or fractures are

almost always caused by a release of stress in the part. Stress is inherent in any material structure. Compressive stress makes a diamond microstructure stronger but as material is removed, the stress in the microstructure is relieved making it more susceptible to cracking or breaking.

Cracks or Fractures in Wire Die Cores

There are four basic types of cracks or fractures seen in wire dies; U-shaped cracks, Vertical cracks, Horizontal cracks and Web or multiple cracks. Each one of these has a distinct appearance and specific causes. **U-Shaped Cracks** (photo 4) are vertical fractures/cracks that turn downward at the entrance approach and then turn upwards at the bearing zone. The main causes of these are excessive mechanical stress applied to one side of the blank due to misalignment in the casing or voids/uneven distribution of materials in the sintered matrix.

Vertical cracks are cracks traveling from top to bottom of the die bore (graphic 1). They are caused by a) mechanical stress due to the die bore being drilled off center b) a die misaligned when mounted c) insufficient diamond wall thickness due to oversized entrance or die bore d) drill bit contact with the diamond table when the casing was opened e) residual stress relief from cobalt pool in the diamond table or e) the hole was bored before mounting of blank.



Photo 1 – Wire dies in series to incrementally reduce wire diameter



Photo 2 – Tungsten wire is heated before drawing



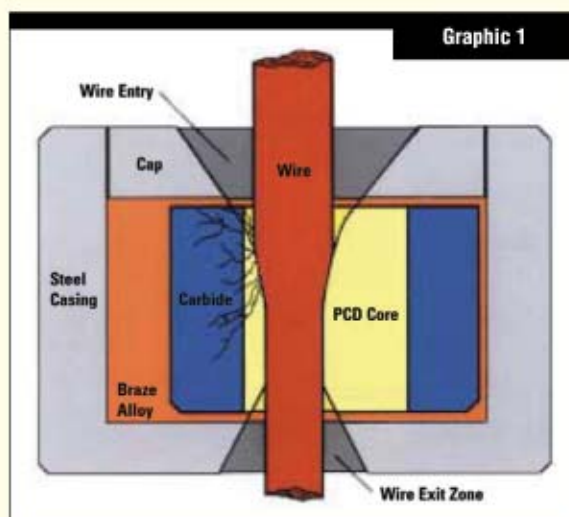
Photo 3 – Wire die casing containing diamond nib being sintered by induction heating



Photo 4



Photo 5



Graphic 1



Photo 6

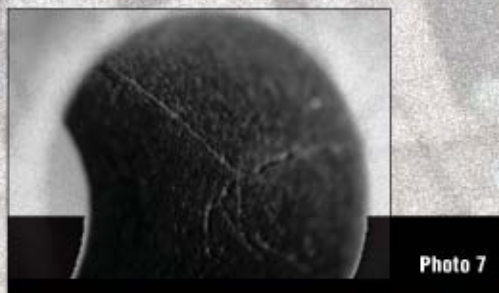


Photo 7

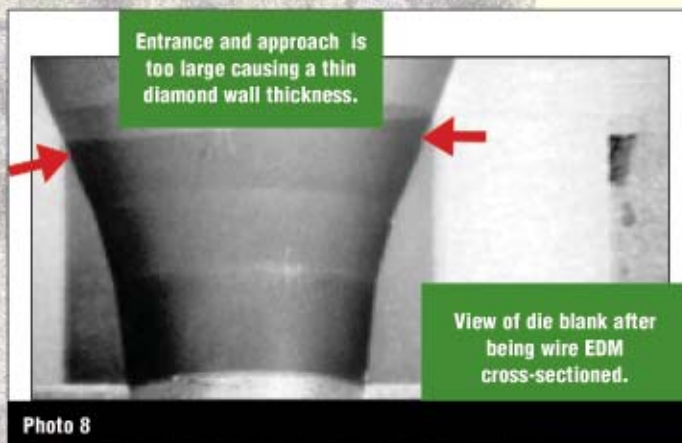


Photo 8



Photo 9

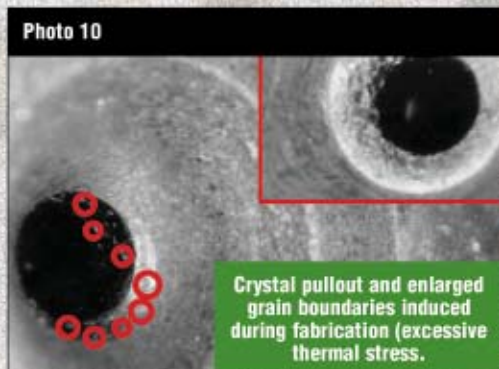


Photo 10

Horizontal Cracks are cracks that travel around the bore diameter. Typically these happen because of the development of a wear ring serving as a stress riser or from gaps in the braze alloy after sintering that cause mechanical stress (*photo 5*). Horizontal cracks can also develop because there are gaps from press fitting the blank in the case that can cause mechanical stress or the blank abrades the steel casing during the mounting operation. Finally, they could also be caused by overheating during laser drilling (*photo 6*) or sintering.

Web or Multiple Cracks are indicative of cracks traveling in non-uniform directions (*graphic 2*).

These can be caused by a wear ring that was generated during the wire drawing process or a misaligned die during the mounting process that induces stress (*photo 7*). Multiple cracks can also happen as a result of excessive thermal damage either from laser drilling, sintering, or lubricant interruption while

drawing. We also see web or multiple cracks when the diamond wall thickness is too thin due to an oversize bore diameter (*photo 8*).

2) Rough Diamond Surface Defects

A rough diamond bore surface is an area in the bore hole that is difficult or impossible to polish due to voids between the diamond crystals (*photo 9*). This area can be granular in appearance. The pull out of diamond crystals may have occurred due to melting of the cobalt secondary phase between the diamond grains. This condition can happen when there is excessive thermal damage either from laser

drilling, sintering or lubricant interruption while drawing. Unsintered diamond, usually isolated to a localized region of the diamond table, can also cause the polycrystalline diamond surface to be rough.

3) Pitting Defects in The Diamond Table

The third type of failure is Pitting (*photo 10*), which is indicated by one or more voids in the diamond table and can be caused by either a diamond crystal pull out or a loss of metal binder. Pitting can result when there is excessive laser burn on one or more isolated regions that did not clean up during fabrication or if there is a metal pool in the diamond structure. It can also come from an agglomeration of small diamond crystals that pull out when overheated.

4) Wear Ring Defects in The Bearing Area

A fourth failure mode is the development of one or more horizontal grooves or fractures in the bearing area or on the top of the reduction area (*photo 11*). Sometimes cracks can develop if not caught in time. These defects occur if a die is used beyond the recommended re-cut time or if the lubrication flow is interrupted during the wire drawing process causing abrasion from material fines.

5) Broken Die Nib Occurrence

A final defect condition exists when there are die cracks through the diamond table and/or carbide ring (*photo 12*). This can occur when the bore diameter is oversize thinning the diamond wall or when a drill contacts the diamond during the casing operation. It can also

happen if there is thermal stress from excessive temperatures or when non-uniform stress is applied to the die during the mounting process. Breakage can happen also when laser drilling before mounting or if there is excessive mechanical stress in the blank prior to finishing.

CONSIDERATIONS FOR LONGER WIRE DIE LIFE AND IMPROVED PERFORMANCE

Knowing how dies fail can aid in heading off catastrophic or premature failure. In polycrystalline dies this wear or failure can be delayed and the die life extended if certain guidelines are followed. First, care should be taken in the manufacturing process to eliminate excessive thermal damage from sintering or laser drilling. Proper alignment of the blank in the casing is critical for reducing breakage.

End users should follow the maximum recommended bore diameter listed in the Diamond Innovations Compax Die Blank Brochure for soft non-ferrous wire. Hard ferrous wire should not exceed 65% of this diameter. Dies need to be recut or repolished on observation of a wear ring in the area of wire contact to maximize die life. It is imperative to keep a constant lubricant flow to the drawing area (*photo 13*) and to filter the lubricant to remove metal fines and to maximize lubricant flow, wire finish and die life.

It is recommended to decrease the bearing length for higher speed drawing and use finer grain die blanks for improved wire surface finish and when drawing ferrous and plated wires. Always use

coarser grain die blanks for drawing larger size non-ferrous wire to provide longer die life and improved wire dimensional control. In high temperature drawing of tungsten and molybdenum wire maintain a reducing atmosphere in the drawing zone to minimize detrimental oxidation effects and maximize die life. Finally it is important to use matched elongation die sets in multi-wire drawing machines.

These precautions and guidelines will extend die life and performance over the long term. ■

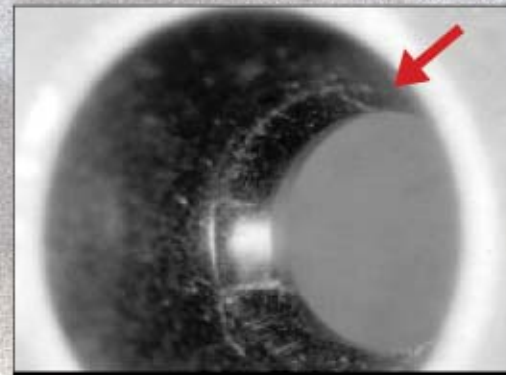


Photo 11

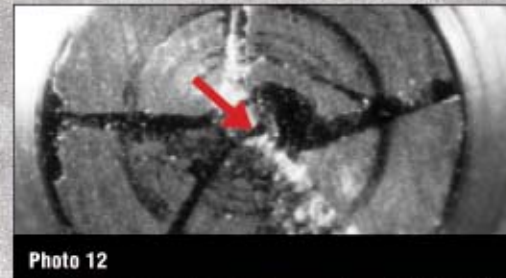


Photo 12

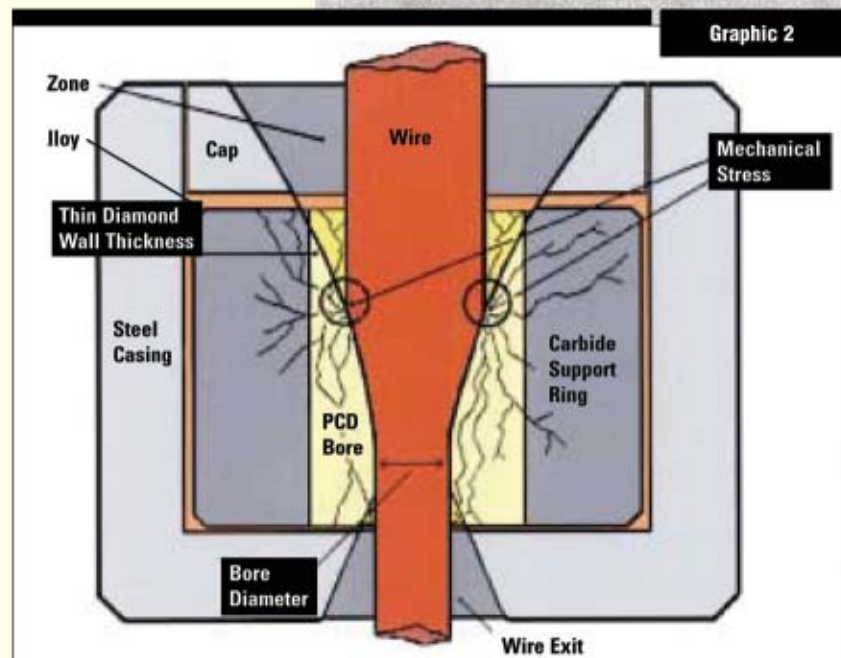


Photo 13 – Wire drawing applications need heavy lubricant to prevent premature die failure



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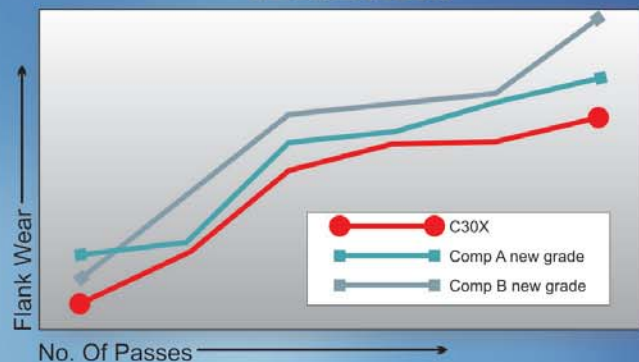
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American Superabrasives Corp.



American Superabrasives Corp announced they have become an agent for a High Speed Brazing System with the capability for Brazing CVD diamond, PCD PCBN and related materials on to a tool body. The Brazing system is an automatic process with consistent quality and repeatability. This machine only takes 28 minutes to braze inserts, from entering the chamber to removal. There are

only six of these high-speed vacuum brazers operating around the world. American Superabrasives also announces the availability of a 75 mm polycrystalline diamond blank. **For additional information on these products contact: AMERICAN SUPERABRASIVES CORP., 59 Ave at the Common, Shrewsbury, NJ 07702, Tel: (732)389-8066 Fax: (732)389-8069 www.diamond-abrasives.com E-mail: njabrasives@aol.com**



AIRBUS A380 USES HOMIDE 250

The high-temperature resin HOMIDE 250 was originally developed by HOS-Technik (www.hostec.com) as high-temperature matrix

resin for the air and space industry. The Airbus A380 which recently started for its maiden flight contains components which were made from this high-tech resin. By modification it is possible to use HOMIDE 250 as binding agent in the diamond and CBN tool industry. Thanks to its excellent thermal and mechanical properties leading diamond wheel manufacturers in US, Japan and Europe use HOMIDE 250. Compared to phenolic resin bound wheels this high-tech product shows unrivalled improved properties, especially as far as wear under extreme conditions is concerned.



LSP3 DIAMOND TECHNOLOGIES, INC., AN SP3 COMPANY, TODAY ANNOUNCED THAT IT HAS EXPANDED ITS OFFERING OF ITS DIABIDE TOOL COATING SERVICE.



sp3 Diamond Technologies, Inc. has also begun selling its DIATip freestanding diamond tool tips and providing a tool tipping service. In conjunction with sp3 Inc.'s recent move into a new headquarters and manufacturing facility, sp3 Diamond Technologies is able to offer increased tool coating capacity and improved lead-times. sp3 Inc. is a full-service provider of products and services related to thin-film and thick-film diamond deposition and other diamond materials. sp3 comprises two companies: sp3 Diamond Technologies and sp3 Cutting Tools. sp3 Cutting Tool's factory is located in Decatur, Indiana, USA. (800-773- 9940) **For further information Contact: sp3 Diamond Technologies, Inc. 2220 Martin Ave. Santa Clara, Ca. 95051 www.sp3inc.com 877-773-9940 diamond@sp3inc.com**

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SPRING RESOURCE DIRECTORY Corrections

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Include under categories and classifications Manufacturers of superabrasive products, Machine Tool builder and Research Facility

NEWS and notes



THE 59TH INDUSTRIAL DIAMOND ASSOCIATION ANNUAL MEETING was held this spring at The Aladdin Resort in Las Vegas, Nevada. Highlights included 60 attendees that enjoyed festivities and technical presentations over the three-day meeting. In addition to a very active business meeting which led to many new programs and initiatives, the first day featured speakers which included a technical presentation from Dr Ion Benea on the science of diamond synthesis and Richard Preuss and Mark Markovic of the US Census Bureau who took the attendees through excellent resources for tracking and reporting

import and export data for our industry. Our Thursday evening banquet honored out going president Joe Haag and welcomed 2005-president Joe Tabeling and his Officers and Board of Directors (see page 4). The last day we were treated to four excellent presentations. Mike Rubell of the Safety and Compliance Institute spent an hour going over various compliance issues we should be aware of that are set by government regulations. We then listened to Gina Martin of Wachovia Bank, who gave us a very insightful Economic outlook for future business. This was Gina's second year speaking with our attendees and due to an overwhelming response she has been asked to join us next year as well. After lunch it was our pleasure to have James Campbell the Industrial Manager from Pratt & Whitney and he gave us an insightful perspective of the way Pratt and Whitney approves vendors and selects new tooling for manufacturing processes. The meeting concluded with S. Clark McEwen from the Canadian Diamond Industry speaking on the new diamond strikes in Canada and their development over the next few years. All in all the meeting was a tremendous success and the membership took a strong step forward heading into the 60th Anniversary and INTERTECH 2006 in Atlanta next April!



THE WIRE ASSOCIATION INTERNATIONAL, INC.
Interwire 2005: a positive industry sign

GUILFORD, Connecticut, USA — The wire and cable industry showed continued signs of resurgence at Interwire 2005, held May 14-19 at the Georgia World Congress Center in Atlanta, Georgia, USA, where the Wire Association International also held its annual meeting, put on a comprehensive technical program and celebrated its 75th Anniversary. Interwire 2005 drew some 5,200 attendees, up 12 percent from 2003. The keynote presentation was by Malay Mukherjee, Chief Operating Officer of Mittal Steel Company who noted that global steel enjoyed a banner year in 2004, even when China's role was taken out of the equation. Trade, he said, has continued to flow towards higher priced markets. Dr. Robert Eisenbeis, Executive Vice President and Director of Research, Federal Reserve Bank of Atlanta, explained that the U.S. economy is doing much better than the business press would have people believe. Growth this decade looks to be averaging 3.6 percent, which is about the same as the 1990s, a period that he said people seem to remember as more vibrant.

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Sept. 7-9

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September 13 -15

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Novi Expo Center
Novi, MI



Sept. 19-22

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Sept. 27-29

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Manufactured Large Single Crystal Diamond

By RICHARD LADD, Sumitomo Electric Carbide, Inc. Diamond Group

Manufactured large single crystal diamond is used in a wide variety of applications including precision cutting tools, wheel dressing tools and wire drawing dies. This article will review the manufacturing process and properties of synthetic single crystal (SSC) diamond and discuss both the mainstream and unusual uses of this unique diamond.

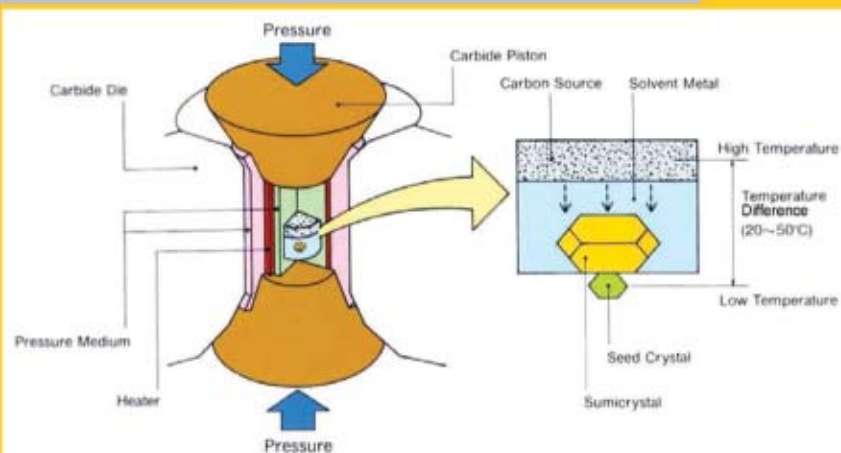


FIGURE 1

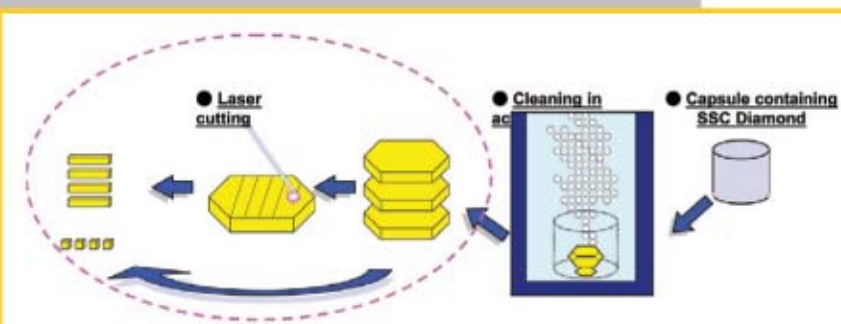


FIGURE 2



FIGURE 3



FIGURE 4

Manufactured large single crystal diamond is used in a wide variety of applications including precision cutting tools, wheel dressing tools and wire drawing dies. This article will review the manufacturing process and properties of synthetic single crystal (SSC) diamond, as well as and discuss both the mainstream and unusual uses of this unique diamond.

MANUFACTURED SINGLE CRYSTAL DIAMOND GROWTH PROCESS

Large single crystal diamond has been manufactured since 1985. These high quality single crystal diamonds are synthesized under ultra-high pressure (50,000 atmospheres) and high temperature (over 1,300° C). A temperature gradient is created in the interior of the heater. This gradient is

used to melt the carbon source into a molten solvent metal. This process allows the diamond to grow on a seed crystal. Maintaining the synthesizing conditions constant over a long period of time is necessary in order to grow large high quality crystals. The growth process is shown in figure 1.

After the growth capsule is removed from the High Pressure (HP)/High Temperature (HT) press, the SSC diamond is acid cleaned. The seed crystal is removed and the grown crystal is cleaved into plates and laser cut in various shapes and sizes. This process is shown in figure 2.

CHARACTERISTICS AND PROPERTIES OF DIAMOND

Depending on the characteristics and physical properties of the elements found in their crystals, (e.g. nitrogen or boron, etc.), diamonds are classified into four types. These types are 1a, 1b, IIa, IIb as shown in Table 1. All of these four types are found in nature, but most of the diamonds are 1a, which contain several hundreds of parts per million (ppm) of nitrogen aggregates. In contrast, SSC diamond is type 1b, which contain evenly distributed nitrogen in quantities of 10- 20 ppm. This provides physical properties different from those of type 1a diamonds

Table 1		TYPE I		TYPE II	
		I a	I b	II a	II b
Abundance in Natural Diamonds		~ 98%	~ 0.1%	1 ~ 2%	~ 0%
Synthetic Diamond		Not Synthesized	Synthetic Powder Synthetic Single Crystal	Synthetic Single Crystal	Synthetic Single Crystal (R & D)
Impurities	Nitrogen (ppm)	~ 2×10^3 Platelet Form	$10^2 \sim 10^3$ Dispersed	~ 1 High Purity	~ 1 Platelet Form
	Others (ppm)		Solvent Metals $10^3 \sim 10^5$		Boron ~100
Color		Clear-Yellow	Green-Brown Yellow	Colorless	Blue
Electric Resistivity ($\Omega \cdot \text{cm}$)		$10^4 \sim 10^{16}$		10^{16}	$10 \sim 10^4$
		Insulator			Semiconductor P Type
Thermal Conductivity (W/m·K)		800	800 ~ 1600	2000	

such as optical characteristics and thermal conductivity.

SSC DIAMOND CUTTING TOOL BLANKS

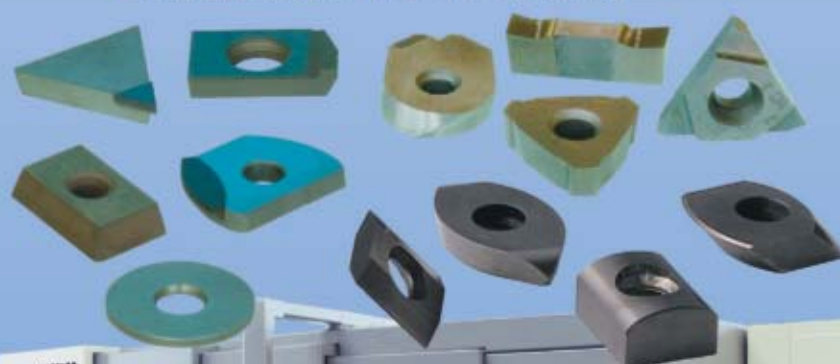
SSC diamond contains controlled amounts of dispersed nitrogen (10-100 ppm). This allows for very consistent and uniform blank to blank properties. In addition to uniformity, the controlled amount of nitrogen also allows superior fracture resistance, high hardness and high thermal conductivity. All these properties significantly affect the life and performance of diamond cutting tools. SSC diamond tools offer superior performance to natural diamond tools for many ultra high precision machining applications. Some applications include machining precious metals, computer memory discs, acrylics where optical quality finishes are required, hard electrolytic nickel molds used in the optics industry, photocopier cylinders and laser scanners. SSC diamond blanks are offered in a large variety of squares, rectangles, triangles and full crystals. Some of the available blanks are shown in figure 3.

A variety of SSC diamond precision cutting tools are shown in figure 4. These tools

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TEST IN DOMESTIC STEEL WIRE MAKER					LIFE: Wire Weight (kg)		
Wire	Size (mm)	Drawing Machine	SSC		Natural		CD/ND Ratio
			Pieces	Average Life	Pieces	Average Life	
Inconel	0.15	No. 1	366	205	189	190	108%
		No. 2	336	212	291	176	120%
		No. 3	432	227	222	196	111%
		No. 4	393	261	345	209	125%
		Total	1527	226	1047	194	117%
SUS305	0.15		21	205	36	178	115%
SUS316	0.15		63	272	54	158	173%

TEST IN DOMESTIC STAINLESS STEEL WIRE MAKER						
Wire	Size (mm)	SSC		Natural		CD/ND Ratio
		Pieces	Average Life	Pieces	Average Life	
SUS304	0.100	97	51.4	Thousands	48.5	106%
	0.108-0.52	59	151.7	Thousands	141.8	107%

TEST IN DOMESTIC STAINLESS STEEL WIRE MAKER						
Wire	Size (mm)	SSC		Natural		CD/ND Ratio
		Pieces	Average Life	Pieces	Average Life	
Cu	0.0215	50	13.3	210	11.9	112%
		50	15.6			130%
	0.030	25	70	25	62.2	113%

Table 2



FIGURE 5



FIGURE 6

include a split radius diamond tool used for machining diffractive optics, a Vee diamond tool used as a form tool or for fly cutting, an insert diamond tool used for generating contact lens molds, a concave radius diamond which is used for form cutting, and a ball end mill diamond tool used for cutting a micro lens array.

SSC DIAMOND DRESSER BLANKS

SSC diamond dresser blanks are cleaved and laser cut into the shape of a prism or rectangle. The unique shape allows a consistent and uniform diamond surface ideally suited for dressing aluminum oxide and silicon carbide wheels. The elongated shape also drastically reduces diamond pull out. SSC diamond dressing tools can often use much smaller carat weight diamond than natural diamond (ND) dressing tools. This is a result of SSC diamond dressing blanks having a consistent cross section of diamond against the grinding wheel. This can be seen in Figure 5. The 2.0 carat ND chisel dressing tool on the left was replaced by a three stone SSC diamond chisel dresser used to dress a silicon carbide wheel on Studer grinder. Stihl Inc. reports that the lower cost SSC diamond dresser lasted nearly ten times as long as the ND dresser.

SSC diamond dressing blanks are used in a wide variety of dressing tools. See figure 6.

SSC DIAMOND WIRE DRAWING DIE BLANKS

SSC diamond wire drawing die blanks are available in various shapes and sizes with the most common being 1/2 of a cleaved crystal. The manufacturing process of SSC allows for the growth of various sizes of diamond crystals. These crystals are then orientated and cleaved in half on the 111 plane to provide a diamond blank for the drawing of ferrous and nonferrous wires. See figure 7.

SSC diamond wire drawing die blanks are available in three styles; crystal, square, and round. The three styles are shown in figure 8.

The diamond die making process involves mounting an SSC diamond blank or ND crystal into the center of the die casing using a high temperature powdered metal matrix. The die is then laser drilled, profiled, polished and final sized. Wire is drawn through a series of dies, reducing the diameter of the wire as it passes through each die. See figure 9.

SSC diamond wire die blanks offer a consistency and uniformity that ND stones cannot match. In addition to uniformity, the controlled amount of nitrogen also allows superior fracture resistance, one of the leading causes of diamond wire die failure. The unique nature of SSC diamond allows it to outperform ND dies in almost every wire drawing application. See Table 2.

In summary, the exceptional properties of SSC diamond allows expansion not only in cutting tools,

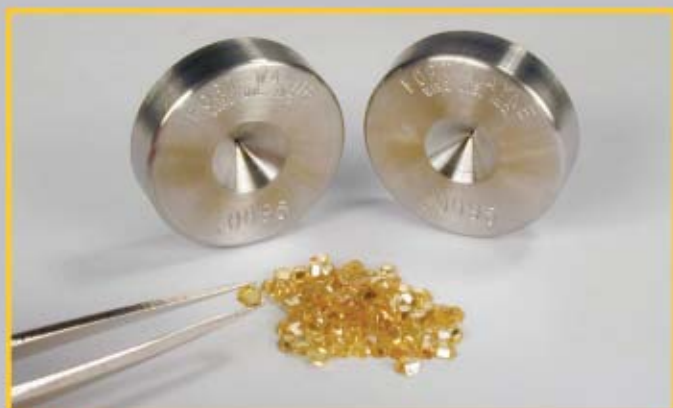


FIGURE 7

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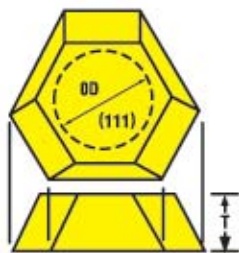
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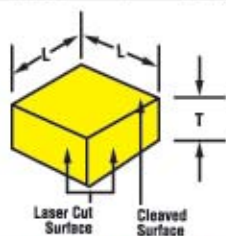
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CRYSTAL

Dimensions (mm)

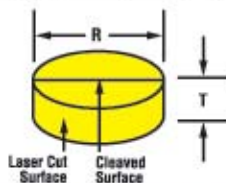
D	T
1.0	0.6
1.0	0.8
1.2	1.0
1.0	1.2
1.2	1.2
1.4	1.4
1.6	1.6
1.8	1.8
2.0	2.0
2.5	2.0



SQUARE

Dimensions (mm)

D	T
1.0	0.6
1.0	0.8
1.2	1.0
1.4	1.1
1.5	1.2
1.8	1.4
2.0	1.6
2.3	1.8
2.5	2.0



ROUND

Dimensions (mm)

D	T
1.0	0.6
1.0	0.8
1.2	1.0
1.4	1.1
1.5	1.2
1.8	1.4
2.0	1.6
2.3	1.8
2.5	2.0



FIGURE 9

wheel dressing tools, and wire drawing dies, but also in incremental business such as water jet nozzles, gage points, and wear parts. This unique product creates an entry into an entire array of applications where diamond has not been used previously. ■

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FIGURE 8



Industrial Diamond Association of America, Inc.

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Principle Business Activity _____
Which applies to your company: _____ Corporation _____ Partnership _____ Sole Proprietorship
Provide names of principle officers or partners: _____
When was your company established? _____ List at least two business references, preferably one is an IDA member (name, company and address of each):
How long has your company been engaged in 1. _____
superabrasive/ultra-hard material industry? 2. _____

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Any company and/or individual classified as a superabrasive/ultra-hard material supplier, tool maker, machine tool builder, end user or related business with offices in the USA, Canada or Mexico is eligible in this category. Only one individual shall be designated by each member company as the IDA Delegate with voting and other privileges described in the By-Laws.

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Check to appropriate category:

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Name of Delegate Voting Member: _____

Title: _____ E-Mail: _____

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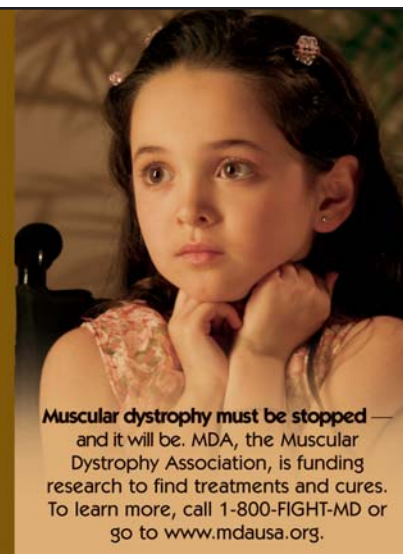
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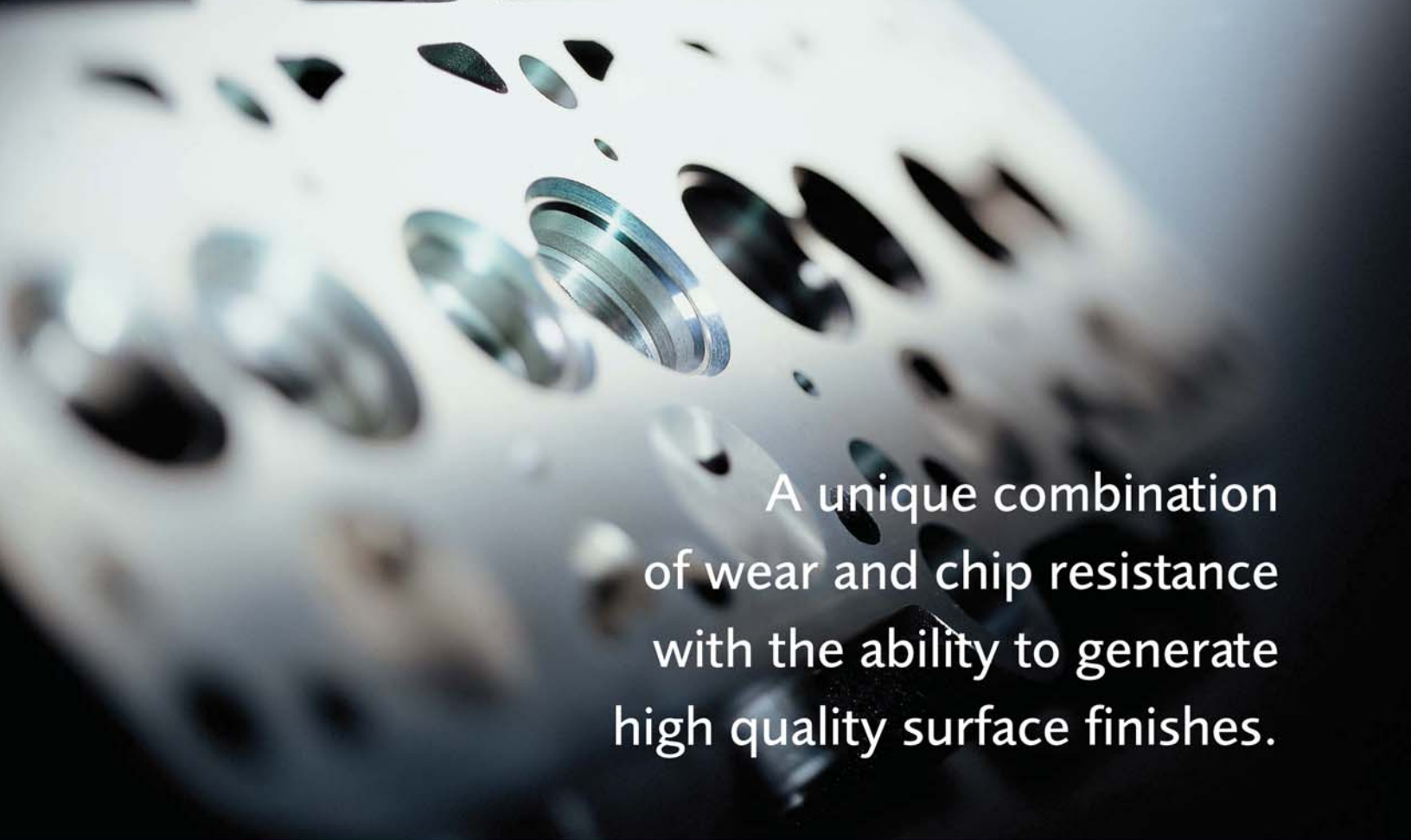
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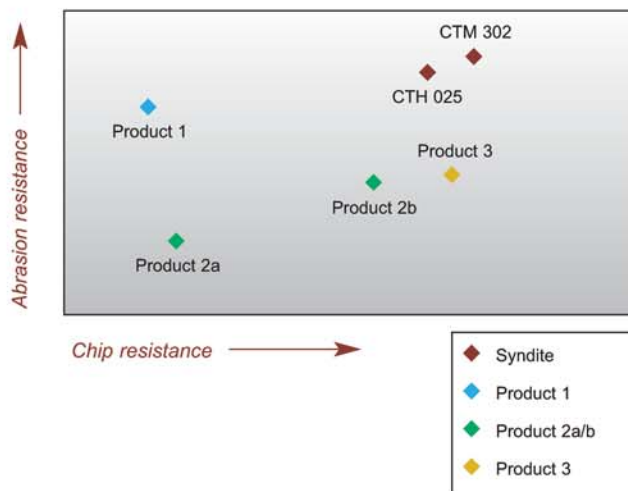
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